General Radio

Type 1433
DECADE RESISTOR

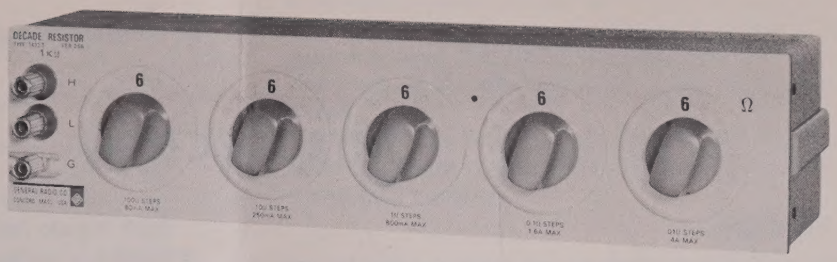


Figure 1-1. Type 1433-T Decade Resistor.

SPECIFICATIONS

Accuracy: The specified tolerances apply for low-current measurement at dc or low-frequency ac (see below).

Over-all Accuracy: The difference between the resistances at any setting and at the zero setting is equal to the indicated value ±(0.01% + 2 mΩ).

Incremental Accuracy: See table. This is the accuracy of the change in resistance between any two settings on the same dial.

Max Current: The max current for each decade is given in the table below and also appears on the panel of each decade box and on the dial plate of each decade resistance unit.

Frequency Characteristic: The accompanying plot shows the max percentage change in effective series resistance, as a function of frequency for the individual decade units. For low-resistance decades the error is due almost entirely to skin effect and is independent of switch setting. For the high-resistance units the error is due almost entirely to the shunt capacitance and its losses and is approx proportional to the square of the resistance setting.

The high-resistance decades (510-E, -F, -G, and -H) are very commonly used as parallel resistance elements in resonant circuits, in which the shunt capacitance of the decades becomes part of the tuning capacitance. The parallel resistance changes by only a fraction (between a tenth and a hundredth) of the series-resistance change, depending on frequency and the insulating material in the switch.

Characteristics of the 1433's are similar to those of the individual 510's modified by the increased series inductance, L_o, and shunt capacitance, C, due to the wiring and the presence of more than one decade in the assembly. At total resistance settings of approx 1000 ohms or less, the frequency characteristics of any of these decade resistors are substantially the same as those shown for the 510's. At higher settings, shunt capacitance becomes the controlling factor, and the effective value of this capacitance depends upon the settings of the individual decades.

Typical Values of R_o, L_o, and C for the Decade Resistors:

Zero Resistance (R_o): 0.001 Ω per dial at dc; 0.04 Ω per dial at 1 MHz; proportional to square root of frequency at all frequencies above 100 kHz.

Zero Inductance (L_o): 0.1 μH per dial + 0.2 μH.

Effective Shunt Capacitance (C): This value is determined largely by the highest decade in use. With the low terminal connected to the shield, a value of 15 to 10 pF per decade may be assumed, counting decades down from the highest. Thus, if the third decade from the top is the highest resistance decade in circuit (i.e., not set at zero), the shunting terminal capacitance is 45 to 30 pF. If the highest decade in the assembly is in use, the effective capacitance is 15 to 10 pF, regardless of the settings of the lower-resistance decades.

Temperature Coefficient of Resistance: Less than ±10 ppm per degree C for values above 100 Ω and ±20 ppm per degree C for 100 Ω and below, at room temperatures. For the 1433's the box wiring will increase the over-all temperature coefficient of the 0.1- and 0.01-Ω decades.

Switches: Quadruple-leaf brushes bear on lubricated contact studs of ⅜-in. diameter in such a manner as to avoid cutting but yet give a good wiping action. A ball-on-cam detent is provided. There are eleven contact points (0 to 10 inclusive). The switch resistance is less than 0.0005 Ω. The effective capacitance is of the order of 5 pF, with a dissipation factor of 0.06 at 1 kHz for the standard cellulose-filled molded phenolic switch form and 0.01 for the mica-filled phenolic form used in the 510-G and 510-H units.

Max Voltage to Case: 2000 V pk.

Terminals: Low-thermal-emf jack-top binding posts on standard ¾-in. spacing; also provisions for rear-panel connections. Shield terminal is provided.

Mounting: Lab-bench cabinet, rack models include mounting hardware.

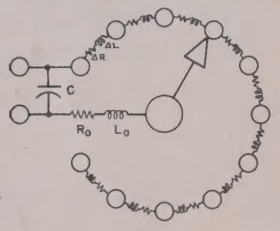
Dimensions and Weights: in. (mm), lb (kg):

	4-dial U, K, J, L, Q	5-dial T, N, M, P, Y	6-dial W, X, B, Z	7-dial F, G, H
Width*	12.3 (312)	14.8 (375)	17.3 (439)	
Height		3.5 (89)		5.3 (135)
Depth	5 in. over-all, 4 in. behind panel (127, 102)			
Net Wt**	4.8 (2.2)	5.8 (2.7)	7 (3.2)	8.8 (4.0)
Ship. Wt**	5.5 (2.5)	6.5 (3.0)	8.5 (3.9)	10.3 (4.7)

* Data given for bench models. All rack models same except 19 in. (483 mm) wide.

** Add approx 1 lb (0.5 kg) for rack-mount hardware.

Type	Total Ohms	Ohms per Step	No. of Dials	Type 510 Decades Used	Catalog Number Bench	Catalog Number Rack
1433-U	111.1	0.01	4	AA, A, B, C	**1433-9700**	**1433-9701**
1433-K	1111	0.1	4	A, B, C, D	**1433-9702**	**1433-9703**
1433-J	11,110	1	4	B, C, D, E	**1433-9704**	**1433-9705**
1433-L	111,100	10	4	C, D, E, F	**1433-9706**	**1433-9707**
1433-Q	1,111,000	100	4	D, E, F, G	**1433-9708**	**1433-9709**
1433-T	1111.1	0.01	5	AA, A, B, C, D	**1433-9710**	**1433-9711**
1433-N	11,111	0.1	5	A, B, C, D, E	**1433-9712**	**1433-9713**
1433-M	111,110	1	5	B, C, D, E, F	**1433-9714**	**1433-9715**
1433-P	1,111,100	10	5	C, D, E, F, G	**1433-9716**	**1433-9717**
1433-Y	11,111,000	100	5	D, E, F, G, H	**1433-9718**	**1433-9719**
1433-W	11,111.1	0.01	6	AA, A, B, C, D, E	**1433-9720**	**1433-9721**
1433-X	111,111	0.1	6	A, B, C, D, E, F	**1433-9722**	**1433-9723**
1433-B	1,111,110	1	6	B, C, D, E, F, G	**1433-9724**	**1433-9725**
1433-Z	11,111,100	10	6	C, D, E, F, G, H	**1433-9726**	**1433-9728**
1433-F	111,111.1	0.01	7	AA, A, B, C, D, E, F	**1433-9729**	**1433-9730**
1433-G	1,111,111	0.1	7	A, B, C, D, E, F, G	**1433-9731**	**1433-9732**
1433-H	11,111,110	1	7	B, C, D, E, F, G, H	**1433-9733**	**1433-9734**



Equivalent circuit of a resistance decade, showing residual impedances.

DECADE-RESISTANCE UNITS

Type	Total Resistance Ohms	Resistance Per Step (ΔR) Ohms	Accuracy of Resistance Increments	Max Current 40° C Rise	Power Per Step Watts	ΔL μH	C** pF	L_o μH
510-AA	0.1	0.01	±2%	4 A	0.16	0.01	7.7–4.5	0.023
510-A	1	0.1	±0.4%	1.6 A	0.25	0.014	7.7–4.5	0.023
510-B	10	1	±0.1%	800 mA	0.6	0.056	7.7–4.5	0.023
510-C	100	10	±0.04%	250 mA	0.6	0.11	7.7–4.5	0.023
510-D	1000	100	±0.01%	80 mA	0.6	5	7.7–4.5	0.023
510-E	10,000	1000	±0.01%	23 mA	0.5	13	7.7–4.5	0.023
510-F	100,000	10,000	±0.01%	7 mA	0.5	70	7.7–4.5	0.023
510-G	1,000,000	100,000	±0.01%	2.3 mA	0.5	—	7.7–4.5	0.023
510-H	10,000,000	1,000,000	±0.01%	0.7* mA	0.5	—	7.5–4.5	0.023

* Or a max of 4000 V, pk.

** The larger capacitance occurs at the highest setting of the decade. The values given are for units without the shield cans in place. With the shield cans in place, the shunt capacitance is from 0 to 20 pF greater than indicated here, depending on whether the shield is tied to the switch or to the zero end of the decade.

INTRODUCTION

1.1 PURPOSE.

The 1433 Decade Resistors are primarily used for precision measurement applications that require excellent accuracy, stability, and low zero resistance. They are convenient standards for checking the accuracy of resistance measuring devices and are often used as components in dc and low-frequency ac bridges and other precision measuring circuits. Many models can be used into the rf range. All models are easily rack-mounted for use as precision adjustments in measurement and control systems.

1.2 DESCRIPTION.

All 1433 Decade Resistors with four, five, and six decades are housed in 3 1/2-inch-high cabinets. The seven-decade models are approximately 5 1/2-inches high. All models are available for either bench use or installation in a relay rack. Refer to specifications.

The panel binding posts are for general use and connection may also be made at the rear, as is often preferred for rack-mounted decade boxes.

The 1433 Decade Resistors are an assembly of 510 Decade-Resistance Units in a single cabinet. Mechanical as well as electrical shielding of the units and switch contacts is provided by the aluminum cabinet and panel. The resistance elements have no electrical connection to the cabinet and panel: a separate terminal is provided for connection to the case.

Each decade has eleven contact studs and ten resistors connected in series. All contact studs in the lower-valued decades have a silver overlay to ensure stability. All decades have a silver zero-setting contact for low and constant zero resistance.

Winding methods are chosen to reduce the effects of residual reactances. The 1Ω, 10Ω, and 100Ω steps use winding techniques that minimize inductance. The 0.01Ω and 0.1Ω steps are straight wire and hairpin-shaped ribbon respectively, and the higher-valued units are straight wound on forms.

1.3 ACCESSORIES AVAILABLE.

Panel-Adaptor Sets are normally supplied with the relay-rack models. These sets (listed in Table 1-2) are also available for mounting 1433 bench models in a standard 19-inch relay rack.

Table 1-2
Type 1433 Panel-Adaptor Sets

Panel-Adaptor Set for:	Catalog Number
1433-U, -K, -J, -L, -Q	0480-2080
1433-T, -N, -M, -P, -Y	0480-2070
1433-W, -X, -B, -Z	0480-2010
1433-F, -G, -H	0480-2091

INSTALLATION AND OPERATION

2.1 DIMENSIONS.

See Figures 2-1 and 2-2 for approximate dimensions of all 1433 Decade Resistor models.

No. of Decades	Dimensions A	Dimensions B
4	12 3/8	12 3/16
5	14 15/16	14 3/4
6	17 1/2	17 5/16

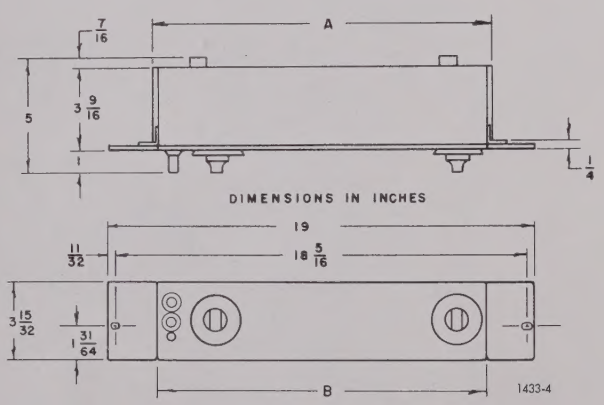


Figure 2-1. Approximate dimensions of 1433 Decade Resistors with 4, 5, and 6 decades. Dimensions A and B apply to bench instruments without Panel-Adaptor Sets.

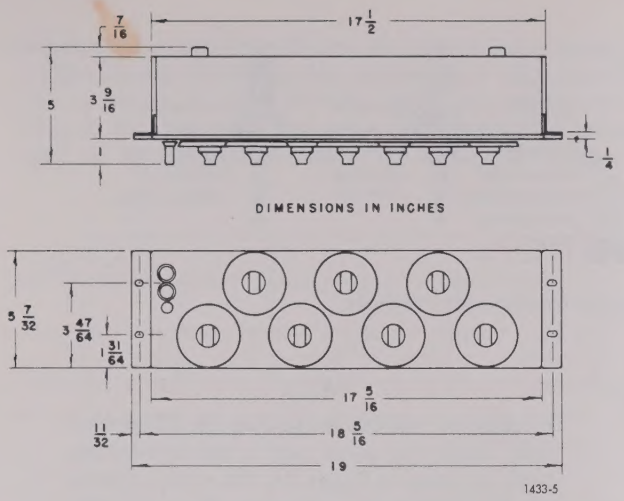


Figure 2-2. Approximate dimensions of 1433 Decade Resistors with 7 decades.

2.2 INSTALLATION.

To install a 1433 Decade Resistor in a standard 19-inch relay rack using the appropriate Panel-Adaptor Set, see Figure 2-3 and proceed as follows:

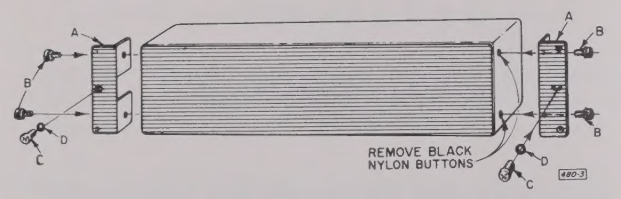


Figure 2-3. Relay-rack installation of a 1433 Decade Resistor.

a. Remove the black nylon buttons from the holes in the side panels of the instrument. These buttons are press fitted and are easily removed with a small screwdriver.

b. Install the adaptor panel (A) on each side of the instrument, using the 3/8-inch locking screws (B) supplied. The holes in the side panels are tapped to receive these screws.

c. Mount the assembly in a standard 19-inch relay-rack cabinet, using the 5/8-inch No. 10-32 screws (C) and nylon washers (D) supplied.

2.3 OPERATION.

2.3.1 CONNECTIONS – GENERAL.

The terminals on the 1433 are standard 3/4-inch-spaced binding posts that accept banana plugs, standard telephone tips, alligator clips, crocodile clips, spade terminals, and wire sizes up to No. 10. See Figure 2-4.

The banana-plug patch cords listed in Table 2-1 are GR catalog items that are readily available for use with the 1433 and associated instruments equipped with 3/4-inch-spaced binding posts.

2.3.2 FRONT-PANEL CONNECTIONS.

Standard 3/4-inch-spaced binding posts are available on the front panel for general use. The high (H) and low (L) binding posts are insulated from the panel and used for regular two-terminal applications. For grounded operation, connect the ground link between the ground (G) terminal and the low (L) terminal. Refer to section 3 (Frequency Characteristics) for a detailed comparison of two- and three-terminal connections.

Table 2-1
Patch-Cord Accessories

Type	Description	Catalog Number
274-NQ	Double-plug patch cord, in-line cord, 36" long	0274-9860
274-NQM	Double-plug patch cord, in-line cord, 24" long	0274-9896
274-NQS	Double-plug patch cord, in-line cord, 12" long	0274-9861
274-NP	Double-plug patch cord, right-angle cord, 36" long	0274-9880
274-NPM	Double-plug patch cord, right-angle cord, 24" long	0274-9892
274-NPS	Double-plug patch cord, right-angle cord, 12" long	0274-9852
274-NL	Shielded double-plug patch cord, 36" long	0274-9883
274-NLM	Shielded double-plug patch cord, 24" long	0274-9882
274-NLS	Shielded double-plug patch cord, 12" long	0274-9862
274-LLB	Single-plug patch cord, black, 36" long	0274-9468
274-LLR	Single-plug patch cord, red, 36" long	0274-9492
274-LMB	Single-plug patch cord, black, 24" long	0274-9847
274-LMR	Single-plug patch cord, red, 24" long	0274-9848
274-LSB	Single-plug patch cord, black, 12" long	0274-9849
274-LSR	Single-plug patch cord, red, 12" long	0274-9850

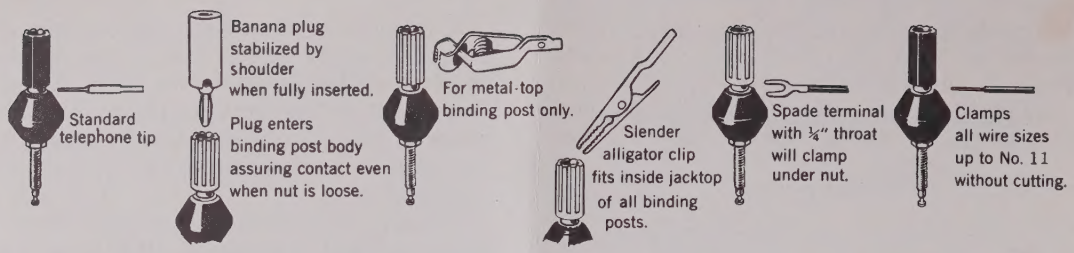

Standard telephone tip
Banana plug stabilized by shoulder when fully inserted.
Plug enters binding post body assuring contact even when nut is loose.
For metal-top binding post only.
Slender alligator clip fits inside jacktop of all binding posts.
Spade terminal with ¼" throat will clamp under nut.
Clamps all wire sizes up to No. 11 without cutting.

Figure 2-4. Methods of connection to binding-post terminals.

2.3.3 REAR CONNECTIONS.

To make connections at the rear of the instrument, refer to Figure 2-5 and proceed as follows:

a. Remove the two 6-32 screws (A) and the panel (B). The high (H) and low (L) terminals on the front panel extend directly to the rear and are available for connection when the panel is removed.

b. Make connection to the rear terminals, using leads equipped with lug or spade connectors, or solder the leads to the terminal lugs provided at the rear of the instrument. If grounded operation is desired, connect the ground link between the ground (G) terminal and the low (L) terminal on the front panel.

c. Reinstall the panel (B), using the two screws (A) previously removed.

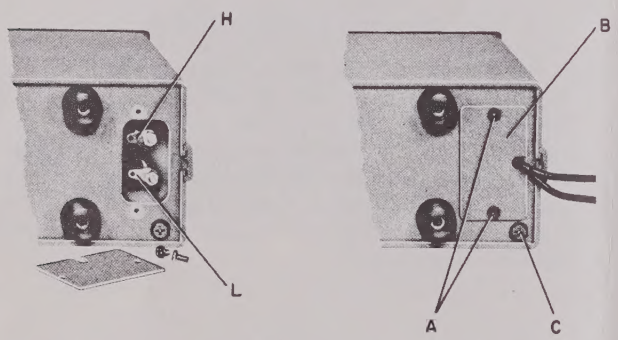


Figure 2-5. Rear view of 1433 Decade Resistor showing exposed rear terminals (left) and rear terminals fully connected (right).

NOTE

In order to provide an opening for connection leads, mount the panel with its slot toward the right, as shown in Figure 2-5. When connections are not made at the rear, mount the panel with its slot facing toward the left to seal the instrument from the outside dust and dirt.

2.3.4 READOUT.

All 1433 decades have clear, easy-to-read dials with numbered steps from 0 to X (X = 10). When setting the decade switches, observe the decimal (reference) point on the panel and remember that X equals ten units. For example, using a 1433-T as shown in Figure 1-1, a value of 54.3Ω is obtained by setting the decade switches as follows:

0 5 4.3 0 = 54.3Ω

or

0 5 4.2 X = 54.3Ω

Note in the above example, that X is equal to a value of ten 0.01Ω units in that decade, or one 0.1Ω unit in the next decade to the left.

The following example illustrates the result of setting all decades in a 1433-T to X.

Dial Settings ..... X X X . X X
Resistance Value .....1,1 1 1 . 1 0Ω

PRINCIPLES OF OPERATION

3.1 FREQUENCY CHARACTERISTICS.

● Single Resistor. As the operating frequency is raised, the residual capacitance and inductance changes the terminal resistance of a single resistor from its low-frequency value. For frequencies where the resistance and its associated residual reactances behave as lumped parameters, the equivalent circuit of such a resistor can be represented as shown in Figure 3-3. In this circuit, L is the equivalent inductance in series with the resistance R, and C is the equivalent capacitance across the terminals.

●Single 510 Decade. An equivalent circuit for a single, shielded 510 Decade Resistance Unit mounted in a 1433 decade box is shown in Figure 3-1 (the values are approximate because they depend on the value of the resistance steps used in the particular decade). The change in effective

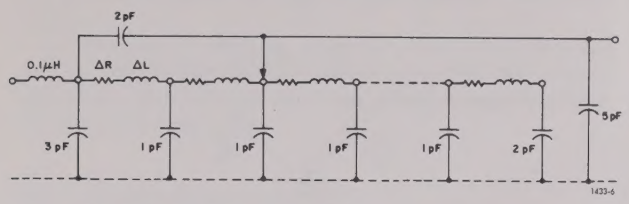


Figure 3-1. Equivalent circuit for a single decade in a decade box.

series* resistance of an individual decade is shown in Figure 3-2. The series resistance of the high-valued decades is reduced because of shunt capacitance at higher frequencies. The series resistance of the low-valued units is increased because of skin effect.

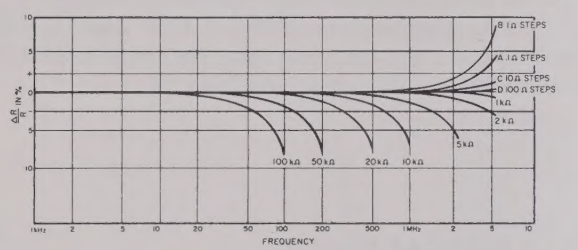


Figure 3-2. Maximum percentage change in series resistance as a function of frequency for Type 510 Decade-Resistance Units.

The parallel** resistance of the high-valued decades changes much less than the series resistance because it is not affected by the lumped shunt capacitance.

●Decade Boxes. When several decades are installed in a 1433 decade box, the complete equivalent circuit becomes too complicated to be useful. A much simpler circuit, such as the one shown in Figure 3-3, is desirable.

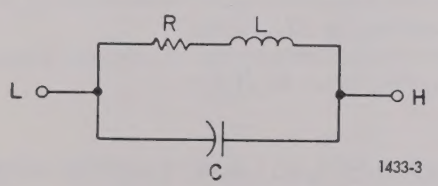


Figure 3-3. A simplified equivalent circuit for a decade box with the low (L) terminal tied to case.

*Series resistance = real part of impedance: Z = R + jX

**Parallel resistance = $\frac{1}{G}$ G= real part of admittance: Y = G + jB

In figure 3-3:

R =setting of the decade box.

$L = L_o + N_1 \Delta L_1 + N_2 \Delta L_2 + \ldots\ldots$

where $L_o \approx 0.1\ \mu H$ per decade x number of decades in unit $+ 0.2\ \mu H$.

$\Delta L_1, \Delta L_2, \ldots \approx$ values from table in specifications.

$N_1, N_2, \ldots \approx$ settings of corresponding decades.

$C = C_o + MC_1$

where $C_o \sim 15$ pF

$C_1 \sim 19$ pF

M =number of unused decades (set to zero) preceding first decade used.

The phase angle (Q) for this circuit is:

$$Q = \omega \left(\frac{L}{R} - RC\right).$$

At low values of R, the $\frac{L}{R}$ term is dominant; at high values of R, the RC term is more important.

The effective series resistance is:

$$R_s = \frac{R}{1 + \omega^2 R^2 C^2}$$

The effective parallel resistance is:

$$R_p = R\left(1 + \frac{\omega^2 L^2}{R^2}\right)$$

At low values, the series resistance remains constant to rather high frequencies because inductance has no effect on R_s. At very low values, skin effect increases R_s (see Figure 3-2).

At high values, the series resistance falls off rather rapidly with frequency, because of capacitance. The parallel resistance, however, is not affected by the lumped capacitance shown in the simple equivalent circuit (see Figure 3-3). The parallel value is affected by distributed capacitance and dielectric loss not shown. An approximate equation that considers these effects on R_p is:

$$R_p \approx R\left[1 + \frac{\omega^2 L^2}{R^2} - \omega R 10^{-13} - 4\omega^2 R^2 10^{-24} - 25\omega^2 R R_y 10^{-24}\right]$$

The $\omega R 10^{-13}$ term represents dielectric loss, the next term represents distributed capacitance in the first decade used (not zero), and the last term represents distributed capacitance in the first decade if it is not used (set at zero), where R_y is the total possible value of that decade. (The last term is not used if the first decade is not set to zero.)

When the case is not tied to either terminal, the decade resistor becomes a three-terminal circuit as shown in Figure 3-4.

In Figure 3-4:

R =setting of the decade box

$L = L_o + N_1 \Delta L_1, + N_2 \Delta L_2 + \ldots\ldots$

where $L_o \approx 0.1\ \mu H$ per decade x number of decades in unit $+ 0.2\ \mu H$.

$\Delta L_1, \Delta L_2, \ldots \approx$ values from table in specifications.

$N_1, N_2, \ldots \approx$ settings of corresponding decades

$C_a = 10\ M_a + 8$ pF.

where M_a = number of unused decades (set to zero) preceding first decade used.

$C_b = 19\ M_b + 20$ pF.

where M_b = number of decades after first used (non-zero) decade.

$C_s = 2$ pF.

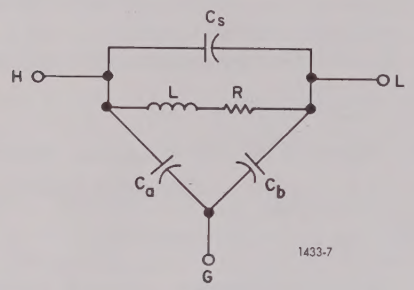


Figure 3-4. Equivalent, three-terminal circuit for a decade box with neither terminal tied to case.

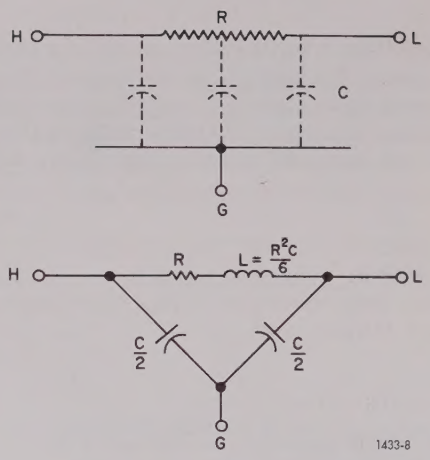


Figure 3-5. Approximation of distributed capacitance effects.

There is also some distributed capacitance (C_d) from the resistor to the case, as shown in Figure 3-5. This capacitance has the effect of increasing the effective inductance by an amount of approximately $N^3R^2C \times 10^{-3}$: where N is the setting of the first used (not zero) decade, R is the total value of the decade resistor, and C is 2 pF.

SERVICE AND MAINTENANCE

4.1 WARRANTY.

We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications. Any instrument or component that is found within the warranty period not to meet these standards after examination by our factory, District Office, or authorized repair agency personnel will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

4.2 SERVICE.

The warranty stated (on page 8) attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the type and serial numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest District Office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

4.3 MINIMUM PERFORMANCE STANDARDS.

Direct-reading, resistance-measuring instruments that are accurate enough for measuring 1433 performance specifications are not commercially available. It is suggested that the following National Bureau of Standards publications be referred to for information on apparatus and procedures necessary for such measurements.

- Methods, apparatus, and procedures for the comparison of precision standard resistors. F. Wenner, J. Research, NBS 25, 229, (1940).
- Precision resistors and their measurement, J. L. Thomas, NBS Circular 470, 32 p (1948).
- Calibration procedures for dc resistance apparatus, P.B. Brooks, NBS Mono 39, (1962).

4.4 SERVICE AND MAINTENANCE NOTES.

4.4.1 GENERAL.

The 1433 Decade Resistor will need little service over the years. Should one of the resistance decades become faulty, it is recommended that the complete switch assembly be replaced. This can be done by competent user personnel or the instrument can be returned to General Radio for service. Use the parts list as a guide in determining which parts may be replaced.

4.4.2 CABINET REMOVAL.

The cabinet is easily removed to gain access to the interior of the instrument: place the cabinet on a flat surface with the rear panel facing upward, remove the three 10-32 screws and lockwashers from the rear panel (c, Figure 2-4), and slide the cabinet up and directly away from the front panel.

To reassemble the unit, place the instrument on a flat surface with its front panel facing down, slide the cabinet into place, and reinstall the three 10-32 screws and lockwashers in the rear panel.

4.4.3 PARTS REPLACEMENT.

Refer to the parts list and Figures 4-1 and 4-2 for 510 ● Decade Resistance Units and other parts that may require replacement.

KNOB REMOVAL. To remove a knob and dial assembly:

a. Set the decade to the X position.

b. Grasp the knob firmly with the fingers and pull it straight away from the panel.

CAUTION

To avoid damage to the knob and dial assembly, do not pry the knob loose with a screwdriver or similar flat tool, and do not attempt to twist the knob from the shaft.

c. Release the No. 3-32 set screw in the dial-assembly hub and pull the assembly from the shaft.

● KNOB INSTALLATION. To install a knob and dial assembly:

a. Mount the dial assembly in the correct position on the shaft (see step a under KNOB REMOVAL).

b. Make certain the dial clears the panel and lock the No. 3-32 set screw.

NOTE

With the dial assembly properly installed, the end of the shaft should not protrude through the dial-assembly hub so that it interferes with proper seating of the knob.

c. Place the knob on the dial-assembly hub and push it in until it snaps into the groove.

PARTS LIST

REF. NO.	DESCRIPTION	PART NO.
J101	JACK, Binding post assembly	4060-0108
J102	JACK, Binding post assembly	4060-0108
J103	JACK, Binding post assembly	0938-2022
S101 thru S107*	DECADE ASSEMBLY, 510-AA, 0.01Ω/step	0510-4001
	DECADE ASSEMBLY, 510-A, 0.1Ω/step	0510-4002
	DECADE ASSEMBLY, 510-B, 1Ω/step	0510-4003
	DECADE ASSEMBLY, 510-C, 10Ω/step	0510-4004
	DECADE ASSEMBLY, 510-D, 100Ω/step	0510-4005
	DECADE ASSEMBLY, 510-E, 1 kΩ/step	0510-4006
	DECADE ASSEMBLY, 510-F, 10 kΩ/step	0510-4007
	DECADE ASSEMBLY, 510-G, 100 kΩ/step	0510-4008
	DECADE ASSEMBLY, 510-H, 1 MΩ/step	0510-4009
Mechanical Replacement Parts:		
	KNOB ASSEMBLY	5500-5420
	DIAL ASSEMBLY	5120-2033*
	DIAL ASSEMBLY	5120-2040*
	DIAL ASSEMBLY	5120-2041*
	CONNECTING WIRE LINK, Ground strap	5080-4802

*See Figures 4-1 and 4-2

Note: There are no Federal Stock Numbers for these parts.

Table 4-1
Resistance Per Decade — All 1433 Models
(Refer to Figures 4-1 and 4-2)

TYPE	S101	S102	S103	S104	S105	S106	S107
1433-U	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX	0.1Ω STEPS 1.6A MAX	.01Ω STEPS 4A MAX			
1433-K	100Ω STEPS 80mA MAX	10Ω STEPS 250 mA MAX	1Ω STEPS 800mA MAX	0.1Ω STEPS 1.6A MAX			
1433-J	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX			
1433-L	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX			
1433-Q	100KΩ STEPS 2.3mA MAX	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	S105		
1433-T	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX	0.1Ω STEPS 1.6A MAX	.01Ω STEPS 4A MAX		
1433-N	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX	0.1Ω STEPS 1.6A MAX		
1433-M	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX		
1433-P	100KΩ STEPS 2.3mA MAX	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX		
1433-Y	1MΩ STEPS 0.7mA MAX	100KΩ STEPS 2.3mA MAX	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	S106	
1433-W	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX	0.1Ω STEPS 1.6A MAX	.01Ω STEPS 4A MAX	
1433-X	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX	0.1Ω STEPS 1.6A MAX	
1433-B	100KΩ STEPS 2.3mA MAX	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX	
1433-Z	1MΩ STEPS 0.7mA MAX	100KΩ STEPS 2.3mA MAX	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	S107
1433-F	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX	0.1Ω STEPS 1.6A MAX	.01Ω STEPS 4A MAX
1433-G	100KΩ STEPS 2.3mA MAX	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX	0.1Ω STEPS 1.6A MAX
1433-H	1MΩ STEPS 0.7mA MAX	100KΩ STEPS 2.3mA MAX	10KΩ STEPS 7mA MAX	1KΩ STEPS 23mA MAX	100Ω STEPS 80mA MAX	10Ω STEPS 250mA MAX	1Ω STEPS 800mA MAX

Form 1433-0100-B
ID None
February 1973

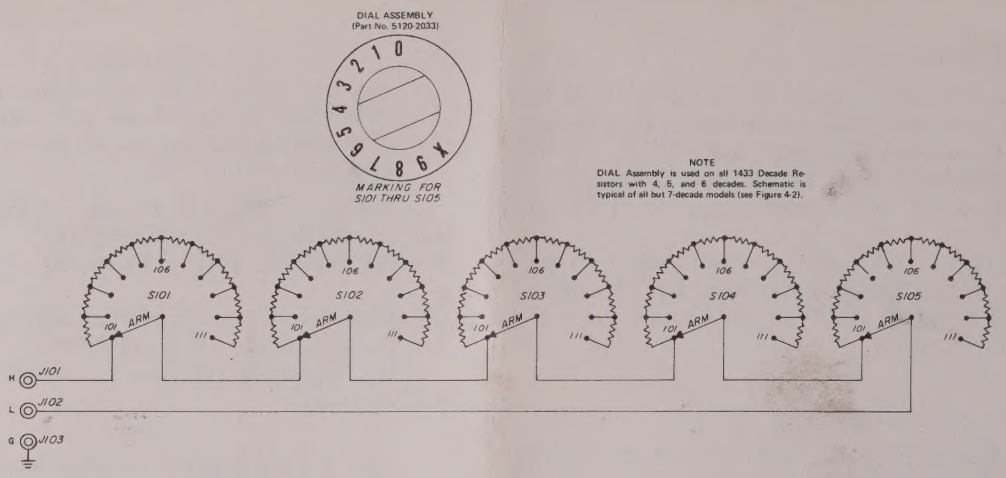


Figure 4-1. Schematic diagram for Type 1433-T, -N, -M, -P, and -Y Decade Resistors.

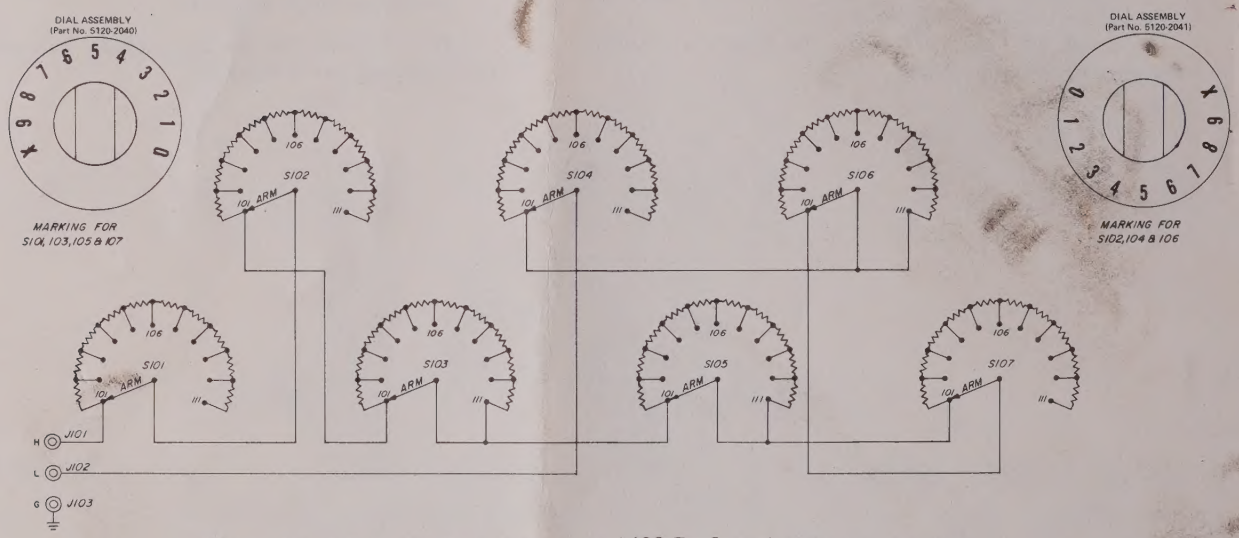


Figure 4-2. Schematic diagram for Type 1433-F, -G, and -H Decade Resistors.

WARRANTY

We warrant that this product is free from defects in material and workmanship and, properly used, will perform in full accordance with applicable specifications. If, within a period of ten years after original shipment, it is found, after examination by us or our authorized representative, not to meet this standard, it will be repaired or, at our option, replaced as follows:

- No charge for parts, labor or transportation during the first three months after original shipment;
- No charge for parts or labor during the fourth through the twelfth month after original shipment for a product returned to a GR service facility;
- No charge for parts during the second year after original shipment for a product returned to a GR service facility;
- During the third through the tenth year after original shipment, and as long thereafter as parts are available, we will maintain our repair capability and it will be available at our then prevailing schedule of charges for a product returned to a GR service facility.

This warranty shall not apply to any product or part thereof which has been subject to accident, negligence, alteration, abuse or misuse; nor to any parts or components that have given normal service. This warranty is expressly in lieu of and excludes all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose, and all other obligations or liabilities on our part, including liability for consequential damages resulting from product failure or other causes. No person, firm or corporation is authorized to assume for us any other liability in connection with the sale of any product.

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